

ATTACHMENT D

NEARSHORE MARINE GEOLOGIC INVESTIGATIONS,  
ICY CAPE TO WAINWRIGHT, NORTHEAST CHUKCHI SEA

by

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## INTRODUCTION

Between August 1 and August 21, 1982, marine geologic investigations were conducted on part of the inner shelf of the northeast Chukchi Sea using the R/V Karluk. Two areas were investigated during the reconnaissance study, the nearshore region from Icy Cape to Wainwright and the nearshore region north of Skull Cliff to 14 km north of Pt. "Barrow. This report summarizes the results of the reconnaissance investigations from Icy Cape (70° 20' N) north to Wainwright (70° 36' N') (figure 1). The purpose of this continuing investigation is to define the marine processes, identify geologic hazards and characterize the sea floor for nearshore regions generally shallower than 30 m depth on the inner shelf of the Chukchi Sea.

Approximately 138 km of side-scanning-sonar records, subbottom profiles (Uniboom) and bottom profiles were collected during this study (figure 2). Eight surficial grab samples were collected for sediment analyses.

The study area is bordered on the east by the gently sloping coastal plain. The Kuk River enters the Chukchi Sea through Wainwright Inlet. The coastal region is bounded by low vegetated cliffs in the northern part of the study area adjacent to Wainwright Inlet. The cliffs rapidly decrease in height and form a sloping surface toward the Chukchi Sea southwest of Wainwright. A narrow barrier island chain dominates most of the coastal area from approximately 25 km south of Wainwright to south of Icy Cape, a distance of 87 km (figure 2). Two inlets, Pingorarak Pass and Akoliakatat Pass, cut through the barrier island into the northern part of Kasegaluk Lagoon. The northern inlet, Pingorarak Pass, was less than 1.5 m deep and contained shoals landward of the barrier island which prevented access to the northern part of Kasegaluk Lagoon by the R/V Karluk. Akoliakatat Pass to the south is narrow, locally obtains depths of 6 m, and was the only access to the northern part of Kasegaluk Lagoon. The pass through the barrier island located 3 km south of Icy Cape contained a sill, less than 1 m deep, with no channeled access from the open ocean to the southern part of Kasegaluk Lagoon.

The oldest bedrock underlying the offshore region between Icy Cape and Wainwright consists of Cretaceous sandstones,

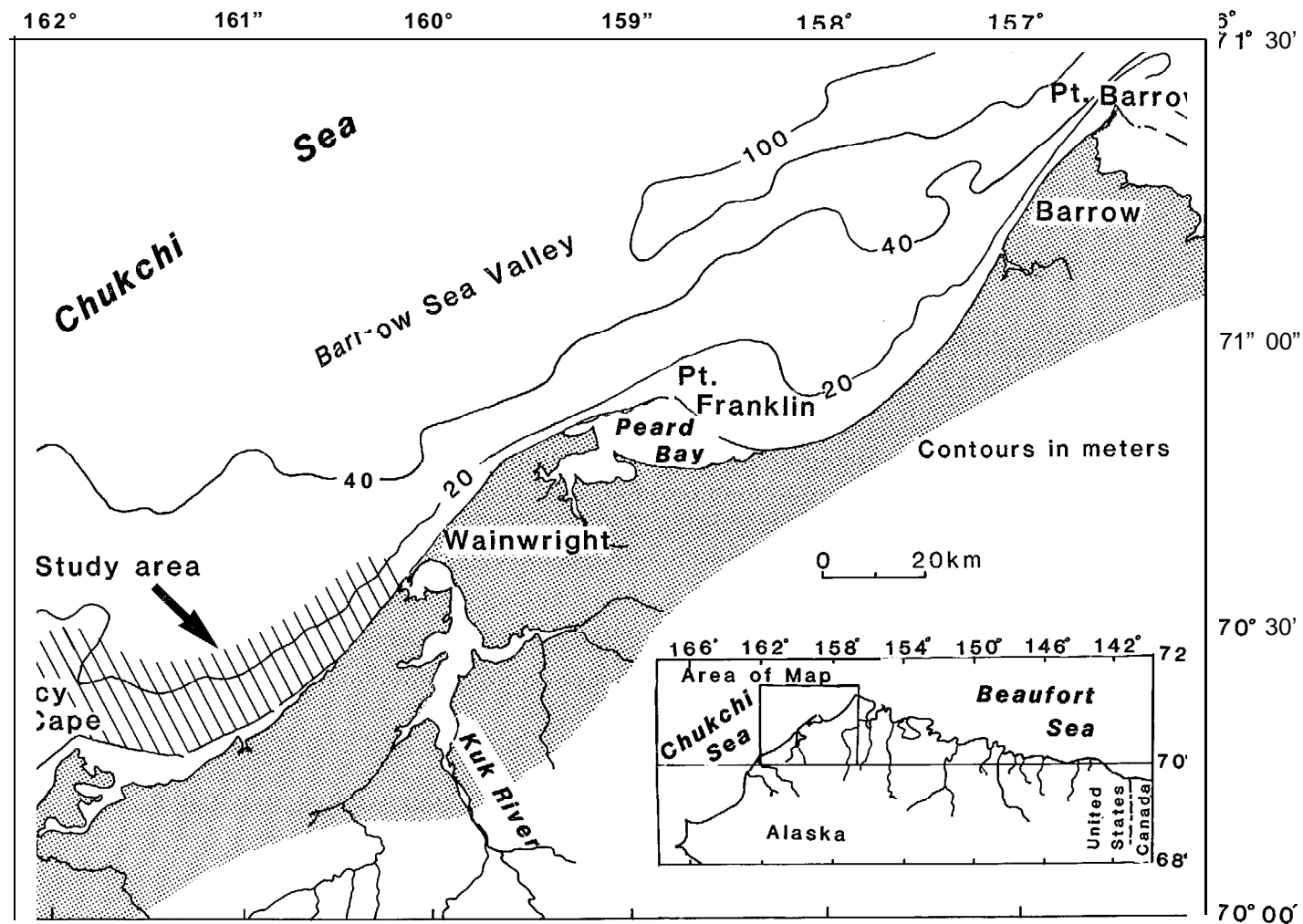


Figure 1. Location of nears here shelf investigated during 1982 in the northeastern Chukchi Sea between Wainwright and Icy Cape.

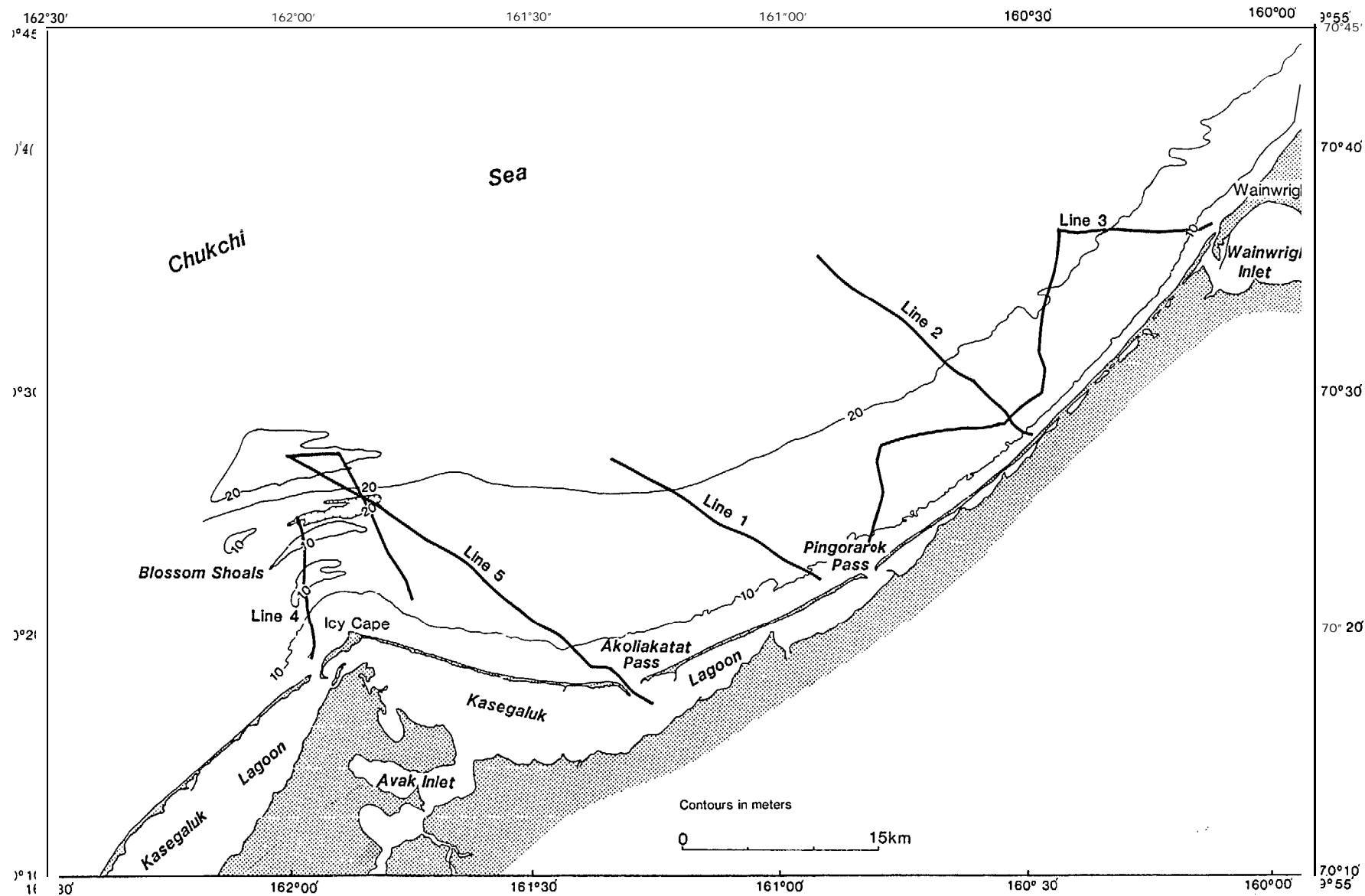


Figure 2. Trackline map 1982 R/V Karluk cruise, Icy Cape to Wainwright, Chukchi Sea.

siltstones and mudstones of the Nanushuk Group (Grantz and others, 1982). The Cretaceous strata are covered by Quaternary sediments throughout this region. Locally, nearshore, in areas of thin sediment cover bedrock may outcrop. The youngest Holocene deposits are the sediments within the sand banks off Icy Cape and within the barrier island chain.

The weather conditions during this part of the study generally were bad, with persistent winds from the west to northwest of up to 45 knots. Associated with these winds were repeated 2 to 3 day storm periods. The short period surface waves generated during the storms were over 2 meters in height. Track lines 1, 2, and 5 are located normal to the western swell direction.

The pack ice was located to the north of Barrow during the time of this part of the study, no floating ice was observed in this southern region.

#### BATHYMETRY

Along the coastal region from Wainwright in the north to Icy Cape in the south the nearshore shelf gradually increases in depth seaward obtaining a depth of 20 m 6 km offshore of Wainwright Inlet and 20 m depth 15 km from shore off Akoliakatat Pass to the south. A series of arcuate sand banks rising up to depths as shallow as 4 to 6 m from 10 to 22 m depth extends seaward over 20 km off of Icy Cape and form Blossom Shoals (figure 3). The sand banks increase in length, contain locally complex bathymetry as the distance increases from shore off Icy Cape.

#### CURRENTS

Wind generated currents, coastal currents and the offshore Alaska Coastal Current dominate the oceanographic regime within this part of the Chukchi Sea. The wind-generated currents result from storms moving from the west or southwest toward the east to northeast. The largest waves observed offshore during this study were over 2 m height with winds varying between 40 to 45 knots.

The northward flowing Alaska Coastal Current dominates the offshore region to the west (Hufford, 1977). The effects of the northward flowing current are documented to the north between Wainwright and Peard Bay where northward migrating sand wave fields exist 3 km from shore (Phillips and others, 1982). The effects of the Alaska Coastal Current in the study area is questionable as sandwaves, which reflect the bottom current trend, were only identified in the southern part of the study area in Blossom Shoals. The sand wave fields exist on the flanks of the sand banks off Icy Cape. Nearshore directly off of Icy Cape northeast migrating sand wave fields exist suggesting a similar trend for the bottom currents. Further offshore and to the northeast of Icy Cape, reversing, westward-directed bottom

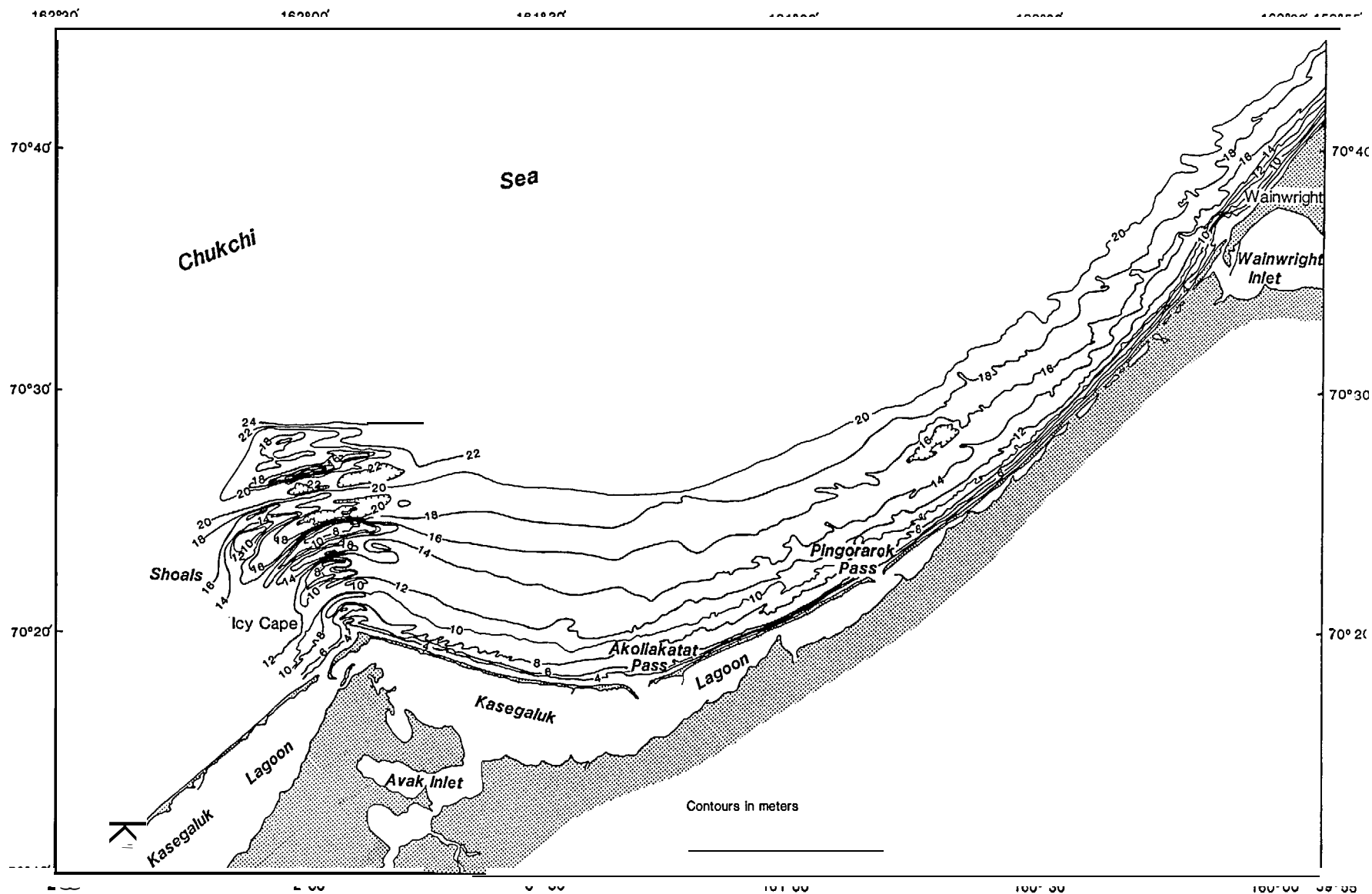


Figure 3. Bathymetric map of nearshore region, Icy Cape to Wainwright, Chukchi Sea. Contours are in meters. Depth data obtained from NOAA hydrographic survey sheets, No. H-7664 and H-7665, 1947.

currents, as indicated by the sand wave orientation, dominate in the outer offshore regions (figure 4). The sand bank located between the northeast flowing currents and the westward flowing currents may have formed as a result of the interaction of these two parallel but reverse currents. The westward flowing currents in the outer offshore region off Icy Cape may have originated as a clockwise gyre formed off of the northward flowing Alaska Coastal Current; or may represent a counter-current flowing parallel to the Alaska Coastal Current or it may represent a seaward extension of a southwest flowing shore parallel coastal current between Wainwright and Icy Cape. The currents, especially off of the capes, appear to be complex and are poorly understood. The capes along the Chukchi Sea represent regions of longshore convergence both of currents and sediment transport (Short, 1975, 1979).

Other evidence of currents as indicated by bedform orientations were only observed nearshore between Akoliakatat Pass and Pingorarak Pass where patches of small-scale shore normal oriented bedforms were observed by side-scanning-sonar in water depths of less than 10 m. The bedforms oriented parallel to the shoreline formed from surface waves moving on shore.

#### QUATERNARY SEDIMENTS

A thin veneer of sediment overlies an irregular truncated surface of a basal seismic unit observed within the high-resolution seismic records. The basal seismic unit, horizontal to gentle dipping strata, is assumed to be of Cretaceous age; the sediment overlying the bedrock is at least of Quaternary age and probably of Holocene age (figure 5).

The areas containing thin sediment cover (2 m or less in thickness) occur in the offshore areas from Wainwright to northwest of Akoliakatat Pass. Regions containing increasing sediment thickness include; 1) the nearshore coastal zone adjacent to the barrier islands, 2) in Blossom Shoals where the largest and thickest sand bank contains over 15 m of Holocene(?) sediment, 3) toward the northwest in the outer-most parts of the offshore areas investigated and 4) locally within a paleochannel of the Kuk River located off of Wainwright Inlet where a maximum channel-fill thickness of 23 m is identified (figure 6).

The regions of thin sediment cover (offshore between Wainwright and Akoliakatat Pass) are probably areas of low sediment input and erosion (wave-generated currents in combination with long shore currents remove sediment). The major depocenter occurs off of Icy Cape (a region of probably converging currents) where the transported sediment is deposited.

The Kuk River paleochannel was initially identified nearshore by Hunter and others (1982), the seaward extension of the paleochannel system was identified during this study (figure 7). The paleochannel is at least 600 m wide, contains a multi-

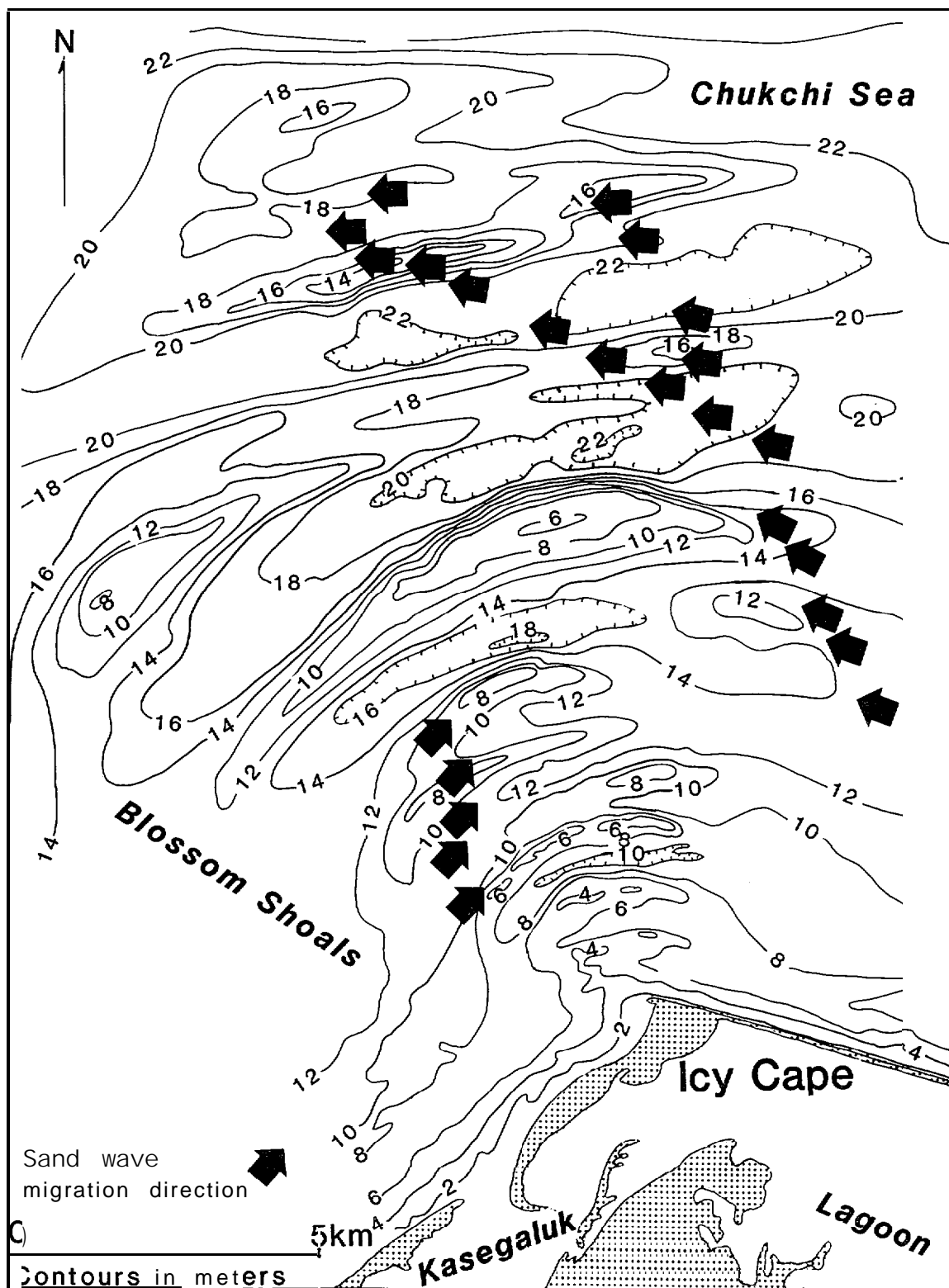


Figure 4. Bathymetric map of the offshore region off Icy Cape, Chukchi Sea. Contours are in meters. A series of arcuate sand banks form Blossom Shoals. The arrows indicate sand wave migration directions and bottom current trends.

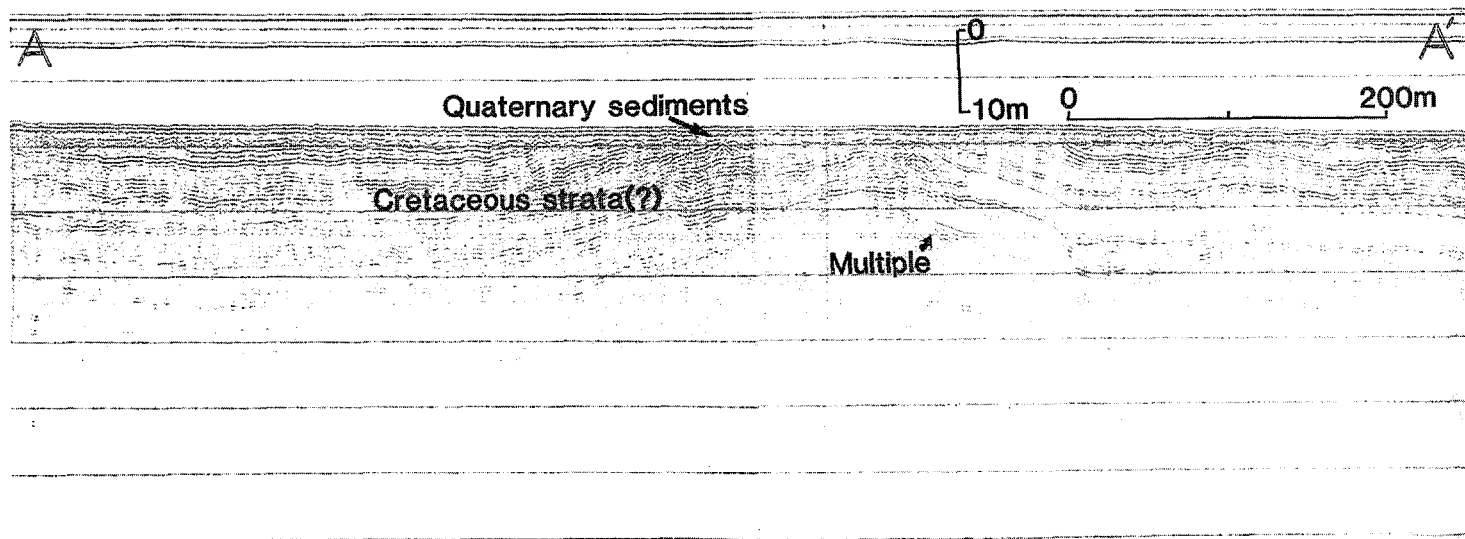


Figure 5. High-resolution seismic profile east of Icy Cape (see figure 6, letter A, for location of profile). The Quaternary sediment cover is thin, less than 2 to 3 m thick, for much of the region northeast of Icy Cape north to Wainwright. The underlying gentle dipping strata is assumed to be of Cretaceous age.

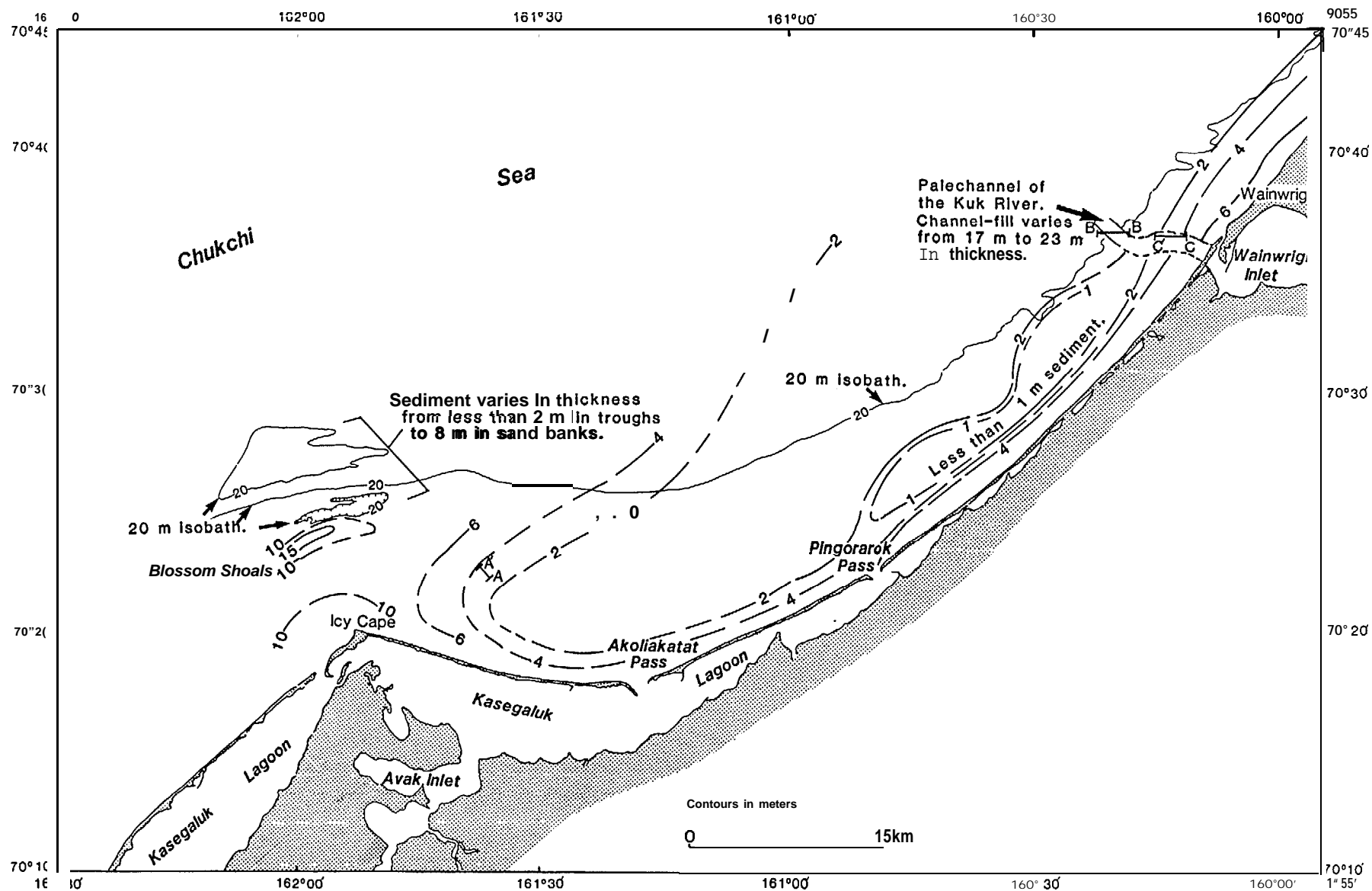


Figure 6. Isopach map of Quaternary sediment cover overlying Cretaceous bedrock between Icy Cape and Wainwright, Chukchi Sea. The maximum sediment thickness, 15 m, occurs in the largest sand bank in Blossom Shoals. The sand banks further offshore contain up to 8 m of Holocene sediment. The letters indicate seismic profile locations.

storied fill history (figure 7) and may also contain gas within the channel fill sediment (figure 8). The tentative identification of gas within the channel-fill is suggested by the "wipe-out" of the acoustic seismic signal (figure 8) and by apparent near-bottom water column anomalies identified on high resolution profiles located in the same area as figure 8. The gas could be biogenetic in origin but most likely was derived from the underlying Cretaceous strata which contains abundant organic plant remains and coal.

#### SURFICIAL SEDIMENTS

The surficial sediments within this coastal area, based on samples and side-scanning-sonar surveys, show that the sediment composition varies from gravelly sand nearshore (possible gravel patches also) to silty sand (sample number 2, figure 9) in the furthest offshore sample. Sand size sediment dominates the texture in the area studied. The sediment distribution reflects the dominance of active erosional and depositional processes on the nearshore zone of this shallow shelf. Bedrock of probable Cretaceous age may outcrop on the sea floor as well as possible consolidated Quaternary or Holocene deposits. Possible Quaternary outcrops are identified directly east of Icy Cape at water depths of 12 m. At this depth distinctive circular-shaped depressions, varying from 12 to 20 m in diameter, are observed on side-scanning-sonar records (figure 10). A raised border surrounds the depressions. The maximum relief from the base of the depression to the area of highest relief is 0.5 m. Approximately 2 m of Quaternary sediment overlies Cretaceous bedrock at this locality. The scattered sea floor depressions may represent initial ice-formed polygons which are now being exposed and eroded by modern sea bed processes or they may represent gas cratering of the sea floor sediments.

Gravel-coarse sediment The regions containing coarse sediment are identified in areas containing thin Quaternary sediment cover and also in areas toward the barrier island from west of Akoliakatat Pass northeast to Wainwright. Three surface grab samples contained abundant gravel associated with sand, samples number 3 (6.7 m depth), 5 (14.0 m depth), and 8 (10.8 m depth). The highest gravel content occurred in the nearshore sample number 3. The gravel varies from angular to well-rounded clasts, the maximum clast size was 4.0 cm. A few iron-stained shell fragments were found with the gravels. Barnacles were the most abundant remains of the biogenetic component.

Monographs define a distinctive sea bed pattern indicative of coarse-grained sediment (coarse sand or gravel) on the sea floor. Light and dark patches (light=sand, dark=coarse sand or gravel) or a mottled pattern usually indicates areas of sediment grain size segregation. Irregular dark patches identified east of Icy Cape at depths of 7.5 m occupy areas of low relief with the lighter colored areas 30 to 80 cm higher (figure 11). Sample number 3 was collected in these dark-light colored areas and

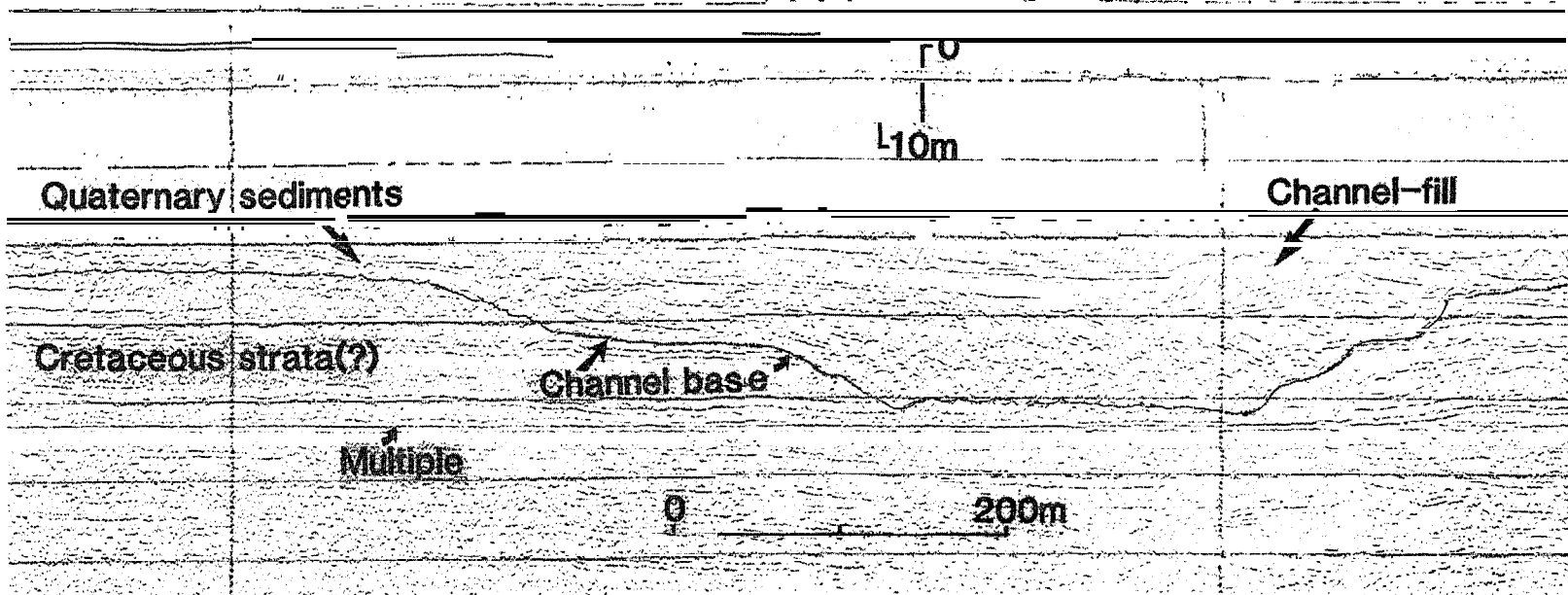


Figure 7. Seismic profile of paleochannel of the Kuk River west of Wainwright, Chukchi Sea. The channel cuts into gently dipping Cretaceous strata. The maximum channel-fill here is 17 m. Both lateral (channel bank) and vertical accretion of the channel is recorded in the upper part of the channel-fill. Only 2 to 3 m of marine sediment overlies the channel-fill (see figure 6, letter B, for profile location).

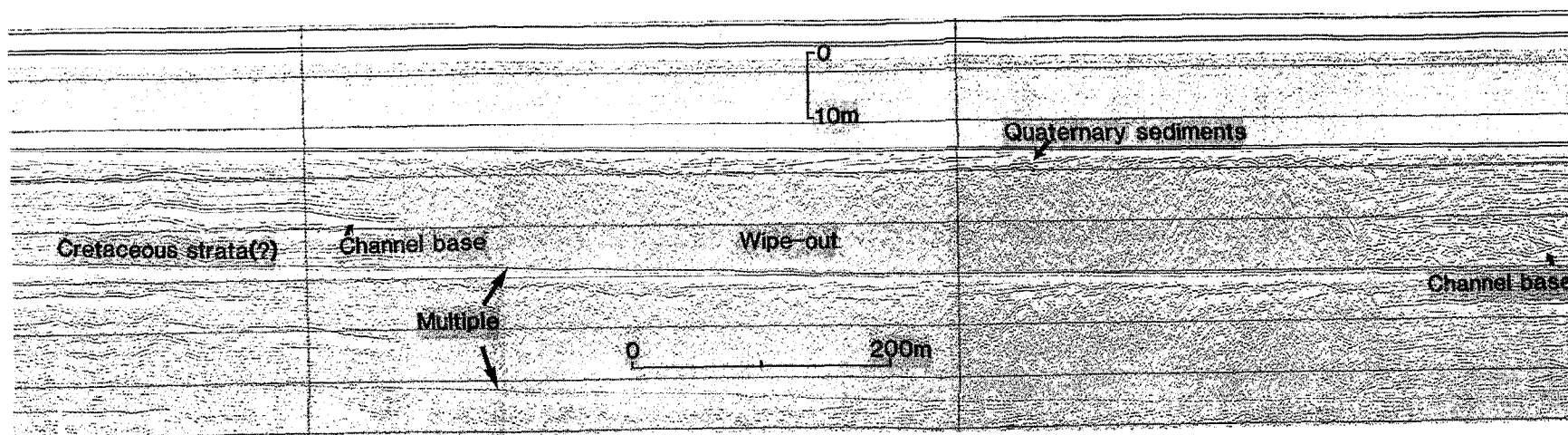


Figure 8. Seismic profile of part of the paleochannel of the Kuk River west of Wainwright, Chukchi Sea. The acoustic seismic signal is completely "wipe-out" suggesting that gas may occur in the channel-fill sediments (see figure 6, letter C, for profile location).

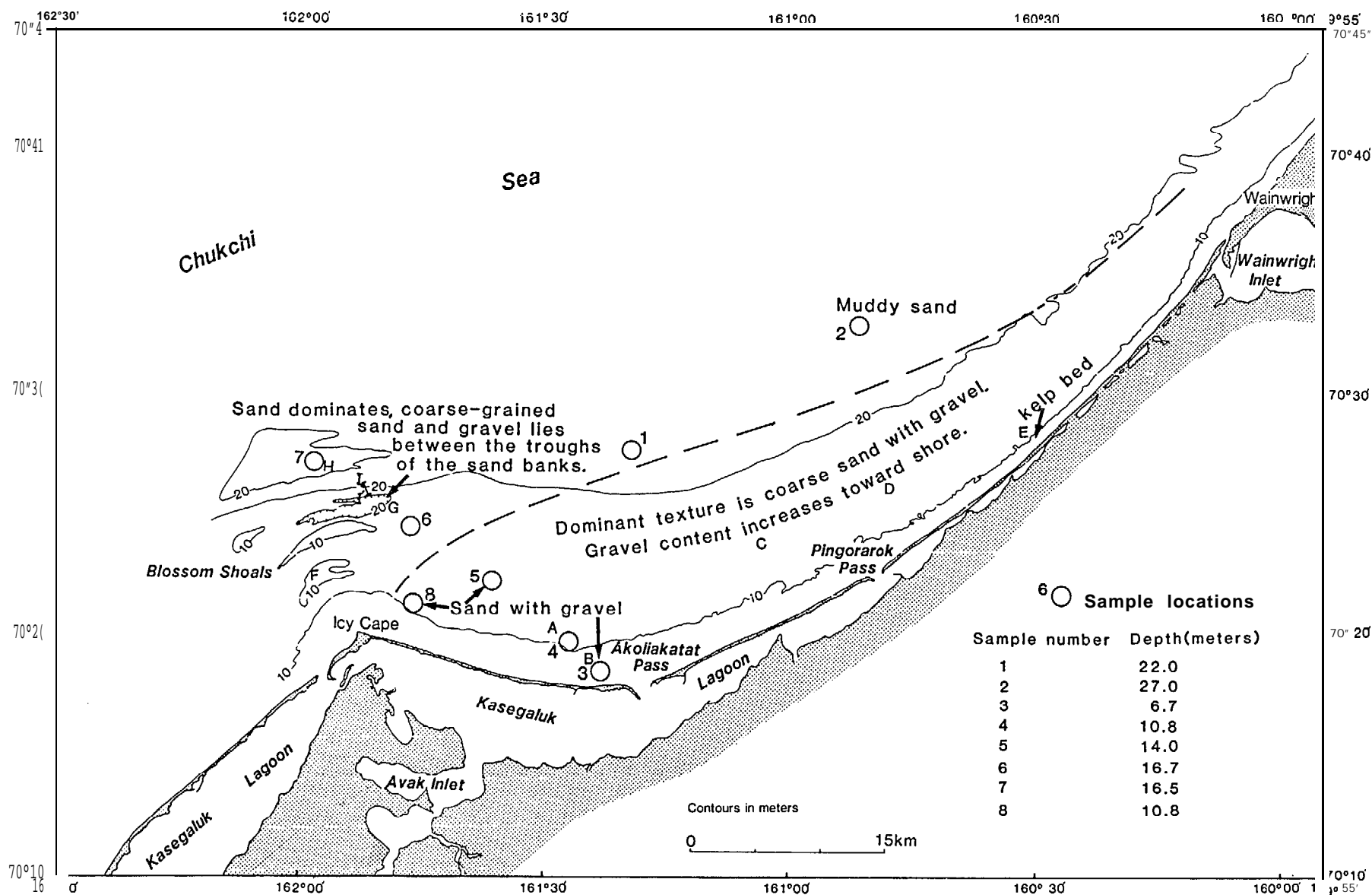
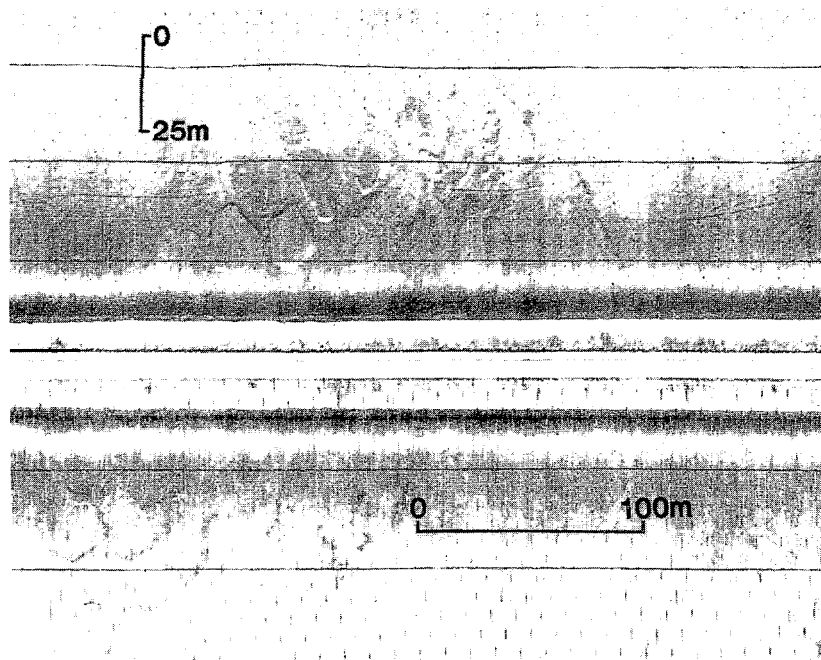


Figure 9. Dominant surficial sediment texture determined from sampling and from monographs. The dash line is an approximate boundary that separates the nearshore **coarse-grained** sediment from offshore **finer-grained** sediment. Sand dominates in the shoals off Icy Cape. The letters indicate the sonograph or seismic profile locations.



**Figure 10.** Possible outcrops of Quaternary sediment at 12 m depth east of Icy Cape. A series of circular to irregular-shaped depressions are exposed on the sea floor. The depressions vary from 12 to 20 m in diameter and contain a raised border. The maximum relief from the floor of the depression to the raised border is 0.5 m (see figure 9, letter A, for location of the sonograph) .

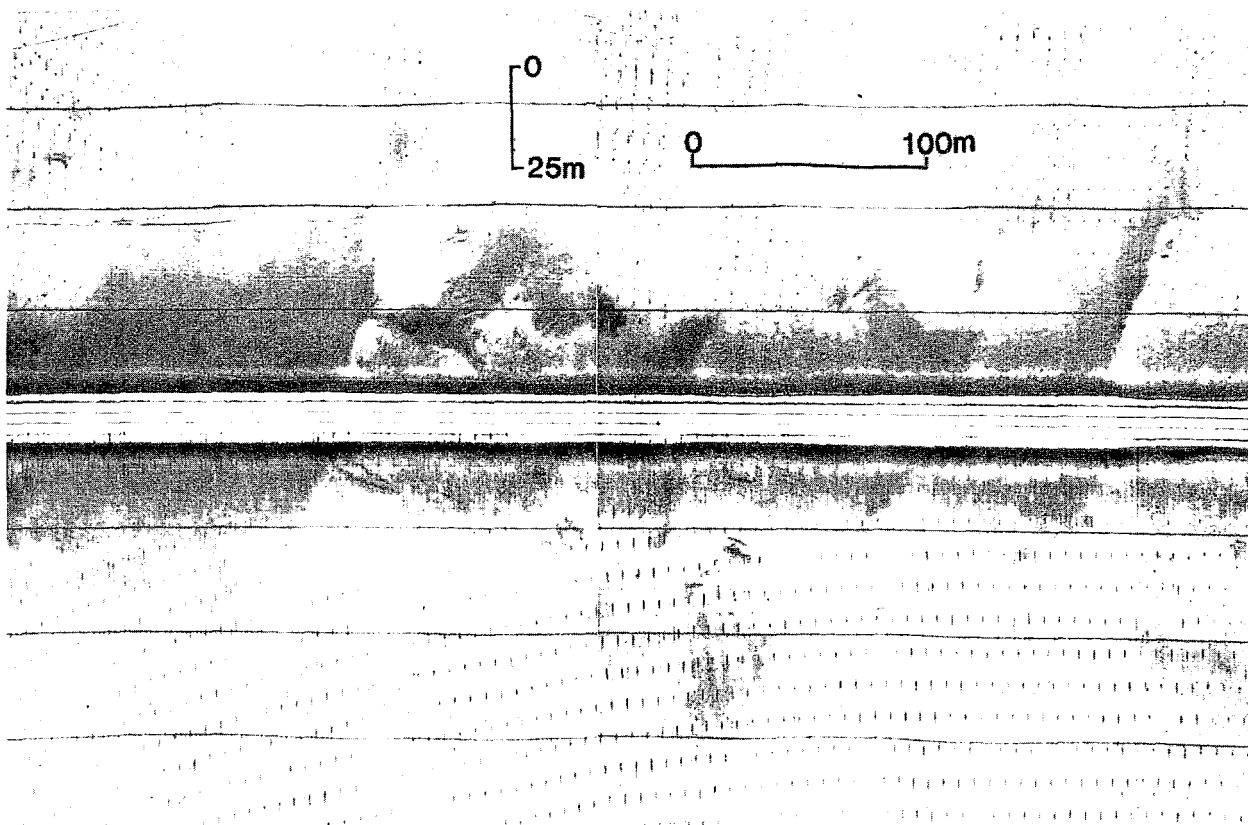


Figure 11. Sonograph containing light (sand) and dark (gravel) patches on the sea floor at a depth of 7.5 m east of Icy Cape. The dark areas occupy areas of lower relief than the light areas. Sample number 3, collected from these light-dark patches, contained abundant gravel with sand suggesting that the dark areas contain gravel or coarse sand and the light areas consist of sand (see figure 9, letter B, for sonograph location).

confirmed the presence of abundant gravel on the sea bed. This strongly suggests that the dark areas identified on the monographs represent **coarse-grained** lag deposits produced by the winnowing of finer-grained sediment. Mottled or dark patches on the sea bed are common within the area from west of **Akoliakatat** Pass to **Wainwright**. Mottled sediment patterns on the sea floor also indicates gravel associated with sand (figure 12a) . At depths generally greater than 14 m, the sea bed contains larger regions of dark mottled patches (figure 12b). Relief ranges from 40 cm up to 1 m with the darker patches usually located in the lower areas of relief. The association of the dark mottled or patchy sea bed with regions of thin sediment cover indicate that coarse sand and gravel probably exists on the sea floor. The **coarse-grained** deposits are produced by erosion of the sea bed leaving a **coarse-grained** lag deposit.

Nearshore, at depths of 11 to 13 m, between **Wainwright** and **Pingorarok** Pass, the sea bed contains a mottled texture as indicated by the sonagraph (figure 13) . The side-scanning sonar fish, when pulled from the water, after passing over this mottled sea bed was completely covered with kelp fronds over 2 m in length and 20 to 30 cm in width. This suggests, as was found to the north off of Skull Cliff (Phillips and others, 1982), that extensive kelp fields may exist in the shallow nearshore zone where coarse sediment or bedrock outcrop on the sea floor. The kelp are attached by their holdfasts to gravel. The extent or depths to which the kelp fields occur between Wainwright and Icy Cape are unknown, but could be expected where the sediment contains gravel-size sediment generally in areas where the sediment cover is less than 1 m thick in the nearshore zone (figure 6).

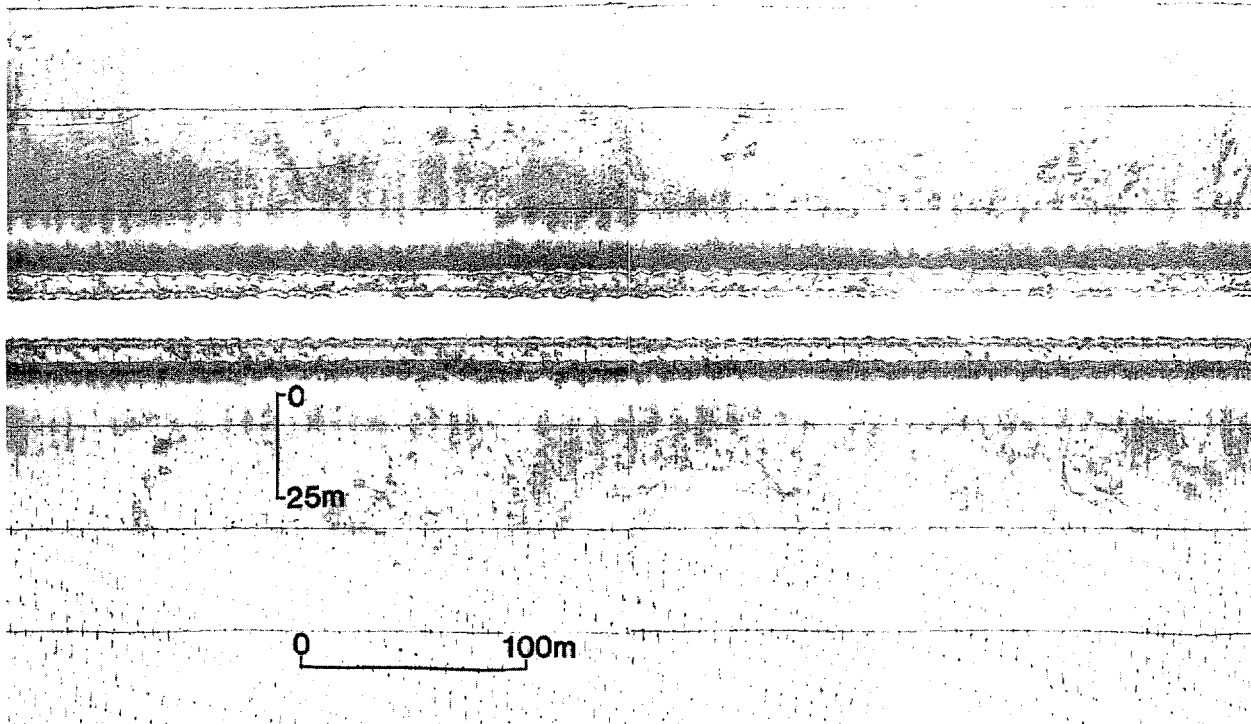
Sand Sand size sediment is probably the most abundant texture within the study area. Sand has accumulated into large banks with local relief up to 16 m off of Icy Cape in Blossom Shoals. Abundant sand wave fields document the active currents in this region. Within the troughs of the sand banks coarse sand or gravel may accumulate by the lateral migration of the sand banks. Silty sand was identified in only one sample (sample number 2) taken at 27 m depth west of Wainwright (figure 9) but could be expected to occur at shallower depths. An overall seaward fining texture probably exists along this coastal area.

#### PROCESSES

The sea floor from Icy Cape to Wainwright is dominated by two physical processes, active currents and ice gouging that modify and change the character of the sea floor. The major effects of the processes are somewhat depth dependent and include both sand wave migration and ice gouging.

Sand waves Migrating bedforms, ripples and sand waves, are only identified at a few localities in the nearshore zone in depths less than 10 m along the coast and off Icy Cape within

A



B

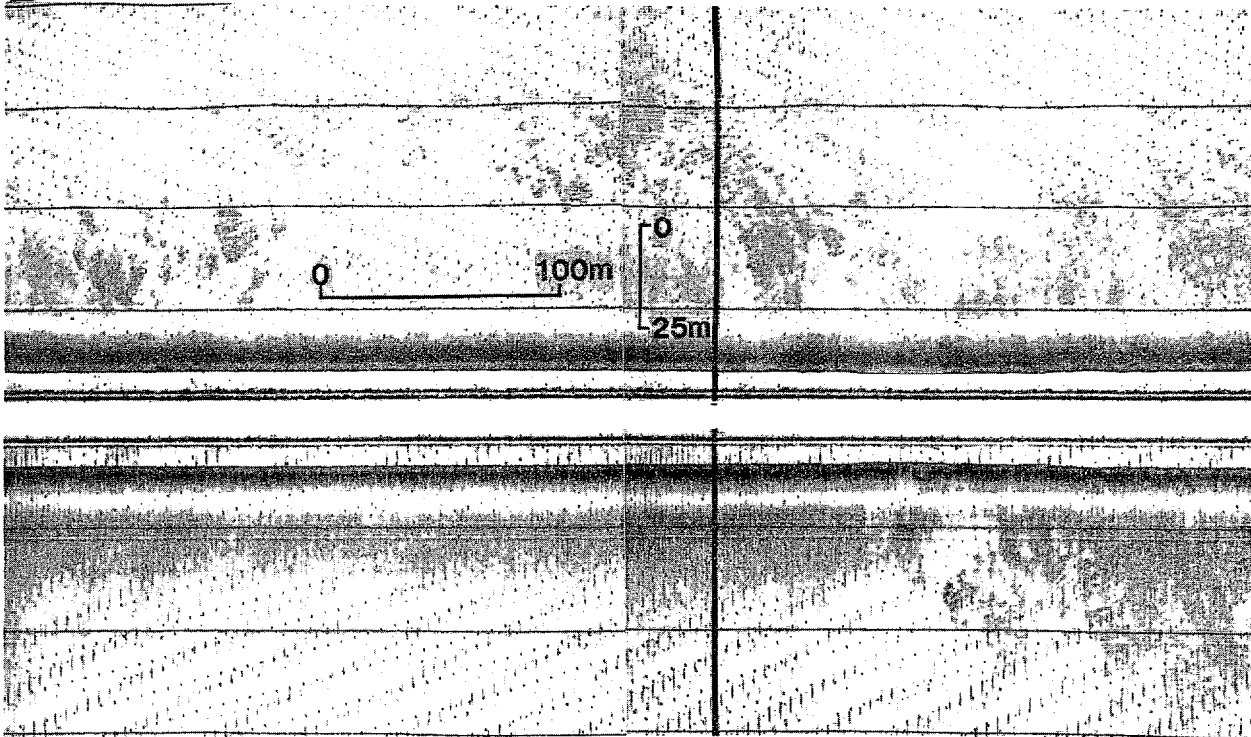


Figure 12. A) **Sonograph** of mottled sea floor at 14.5 m depth west of Pingorarak Pass (See **figure 9**, letter C, for **sonograph** location) . The mottled texture indicates that coarse sediment , sand or gravel, exists on the sea bed. B) **Sonograph** of dark patches on sea floor at a depth of 16 m (see **figure 9**, letter D, for **sonograph** location). Relief on the sea floor can be up to 1 m. The dark areas represent coarse sediment or possibly bedrock outcrops.

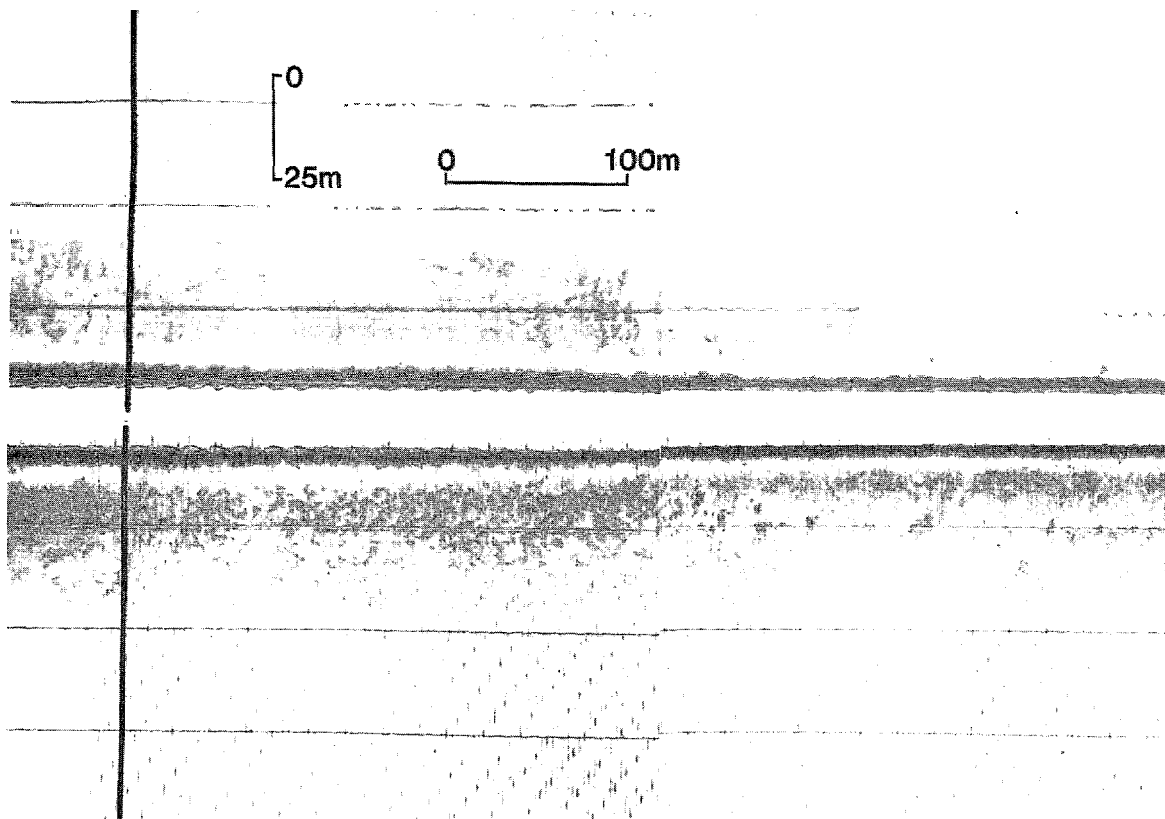


Figure 13. Sonograph obtained nears here at 11 m depth (see figure 9, letter E, for sonograph location) . The mottled sea bed indicates gravel and sand. When the side-scanning sonar was pulled landward of this locality it was completely covered with kelp fronds suggesting that kelp communities exist nearshore where a substrate (gravel) is exposed on which the kelp attaches"

Blossom Shoals. The smallest **bedforms** are identified within sand-gravel patches **nearshore**. The ripples appear symmetric are oriented normal to shore, and have formed from wave action. These shore normal **bedform** fields have been previously identified nearshore (Hunter and others, 1982) and can be expected in the nearshore zone along this coast.

The large sand waves, occurring as distinct **bedform** fields, are located within Blossom Shoals and have resulted in the building of the large arcuate sand banks. The nearshore northeast migrating **bedform** field directly off of Icy Cape (figure 4) is composed of **sinuous-** to straight-crested sand waves with wave lengths of 15 to 20 m and maximum **bedform** height to 2 m at 7.5 m depth (figure 14). The reversing western-directed **bedform** fields identified further offshore, are also composed of **straight-** to sinuous-crested sand waves with wave lengths varying from 25 to 30 m, and heights ranging from 20 cm to 70 cm at 18 m depth (figures 15, 16). Below 20 m depth the sand waves rapidly diminish in height in the troughs of the sand banks suggesting only small-scale **bedforms** (ripples) or gravel lag deposits lie within the troughs. The sand waves generally increase in height from the top of the sand bank down the flanks of the ridges and then diminish in height in the troughs between the sand banks (figure 15). The sand waves are also observed migrating up and **over** the sand banks in essentially the same orientation and migration trend (to the west), (figure 5). Internally within the outer sand banks, based on high-resolution seismic profiles, gentle seaward inclined strata document an offshore (northern-directed) accretion and migration of the sand banks investigated (figure 17). Current erosion on the landward flank of the sand banks, sediment transported over the ridge by migrating **bedforms** and sediment deposition on the seaward flank of the ridges results in the building and migration of the outer sand shoals to the north.

Ice gouging Movement of ice by wind, currents and pack ice pressure results in ice grounding on the sea floor which disrupts the **surficial** sediments forming ice gouges. Ice gouging of the sea floor sediments between Wainwright and Icy Cape generally is limited or sparse with local bathymetric controlled concentrations of gouges (figure 18). Nearshore, at depths less than 10 to 11 m, ice gouges were not observed. Active marine currents, both **longshore** currents and currents generated by shoaling waves, rapidly fill in and eliminate traces of ice gouging nearshore. From 10 m depth seaward to approximately 16 depth, from Wainwright to Pingorok Pass, extending seaward to 18.5 m depth south of Pingorok Pass, there are less than 2 ice gouges per kilometer of track line. The gouges are generally small, narrow, oriented normal or at an angle to the shore or may contain terminations where the ice stopped (figure 19). Most of these nearshore gouges are shallow rarely cutting more than 30 cm into the sea floor.

Between depths of 16 to 18 m out to 22.8 m the maximum ice

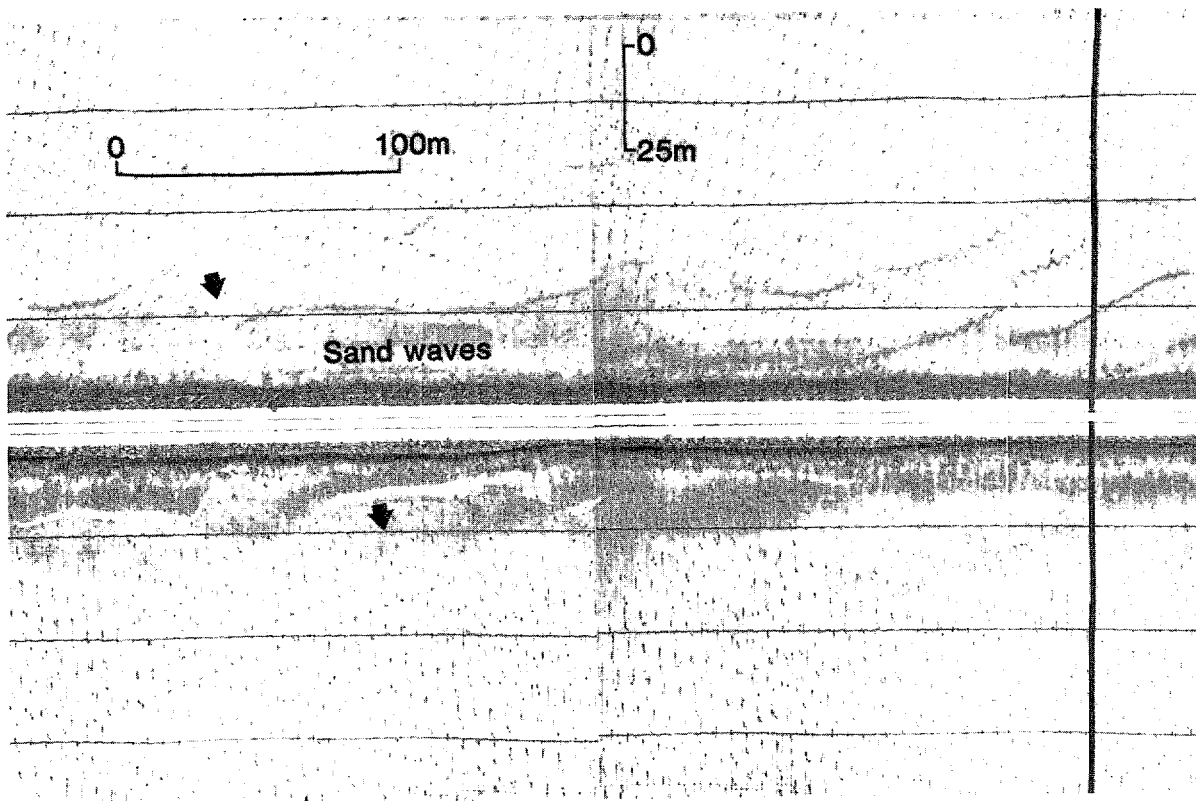


Figure 14. Northeast migrating sand wave field directly off Icy Cape (see figure 9, letter F, for location of sonograph). The straight- to sinuous-crested sand waves are up to 2 m in height at 7.5 m depth. The arrows indicate the migration direction of the bedforms.

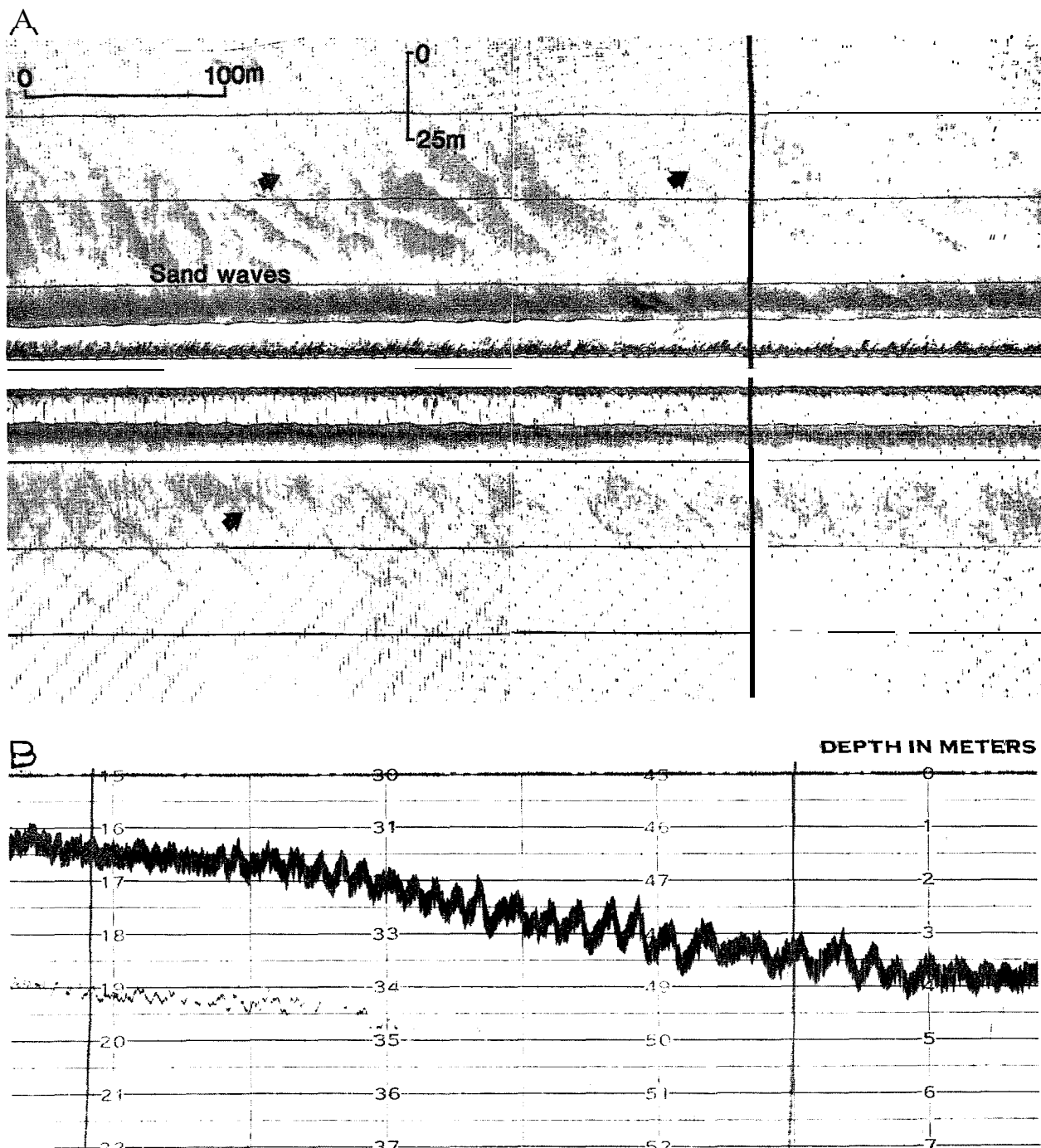


Figure 15. A) Sonograph of straight- to sinuous-crested sand waves at 16.5 to 18.5 m depth north of Icy Cape in Blossom Shoals, Chukchi Sea (see figure 9, letter G, for location of sonograph). The sand waves are migrating to the west. The arrows indicate the migration direction of the bedforms. B) Bottom profile of area in figure A. The crest of the sand bank is to the left. The sand waves increase in height with increasing depth down the flank of the sand bank.

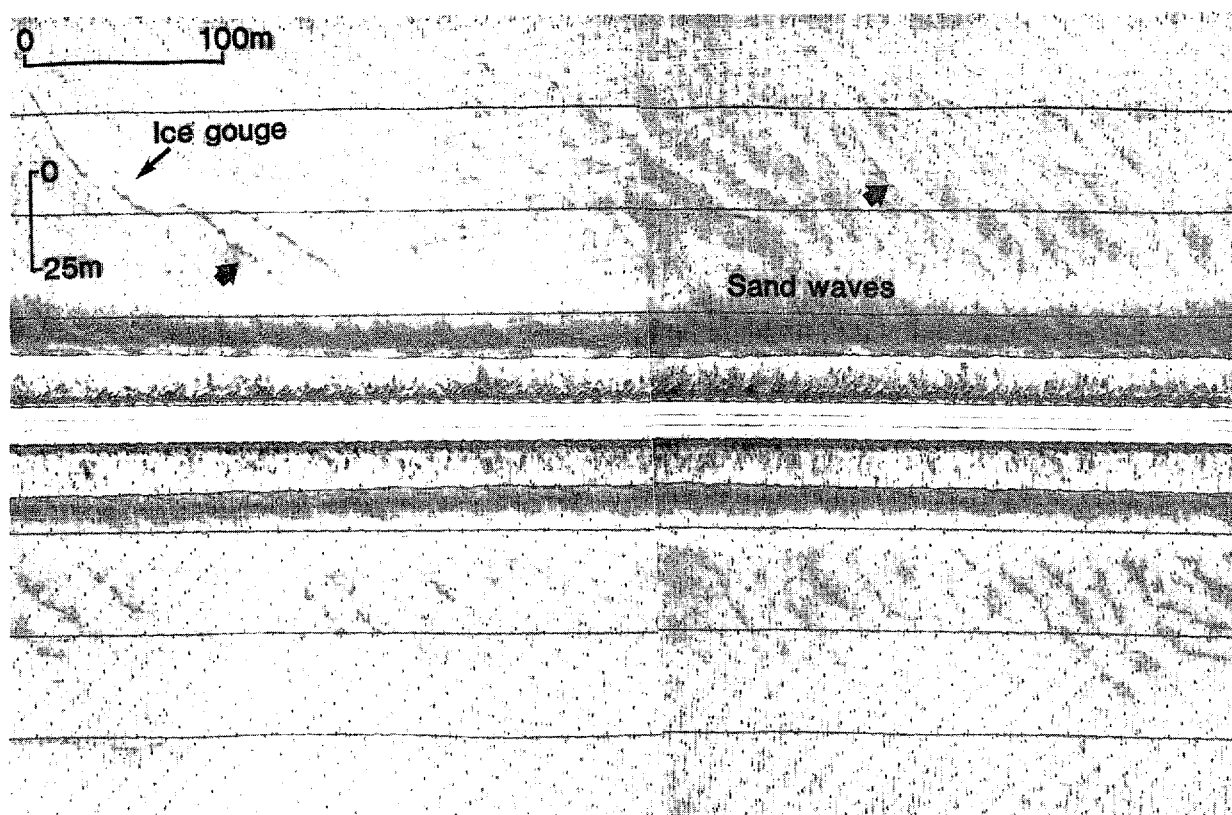


Figure 16. Sonograph of straight- to sinuous-crested waves at 18 m depth northwest of Icy Cape, Chukchi Sea (see figure 9, letter H, for location of monograph). The sand waves are migrating to the west. The arrows indicate the migration direction of the bedforms.

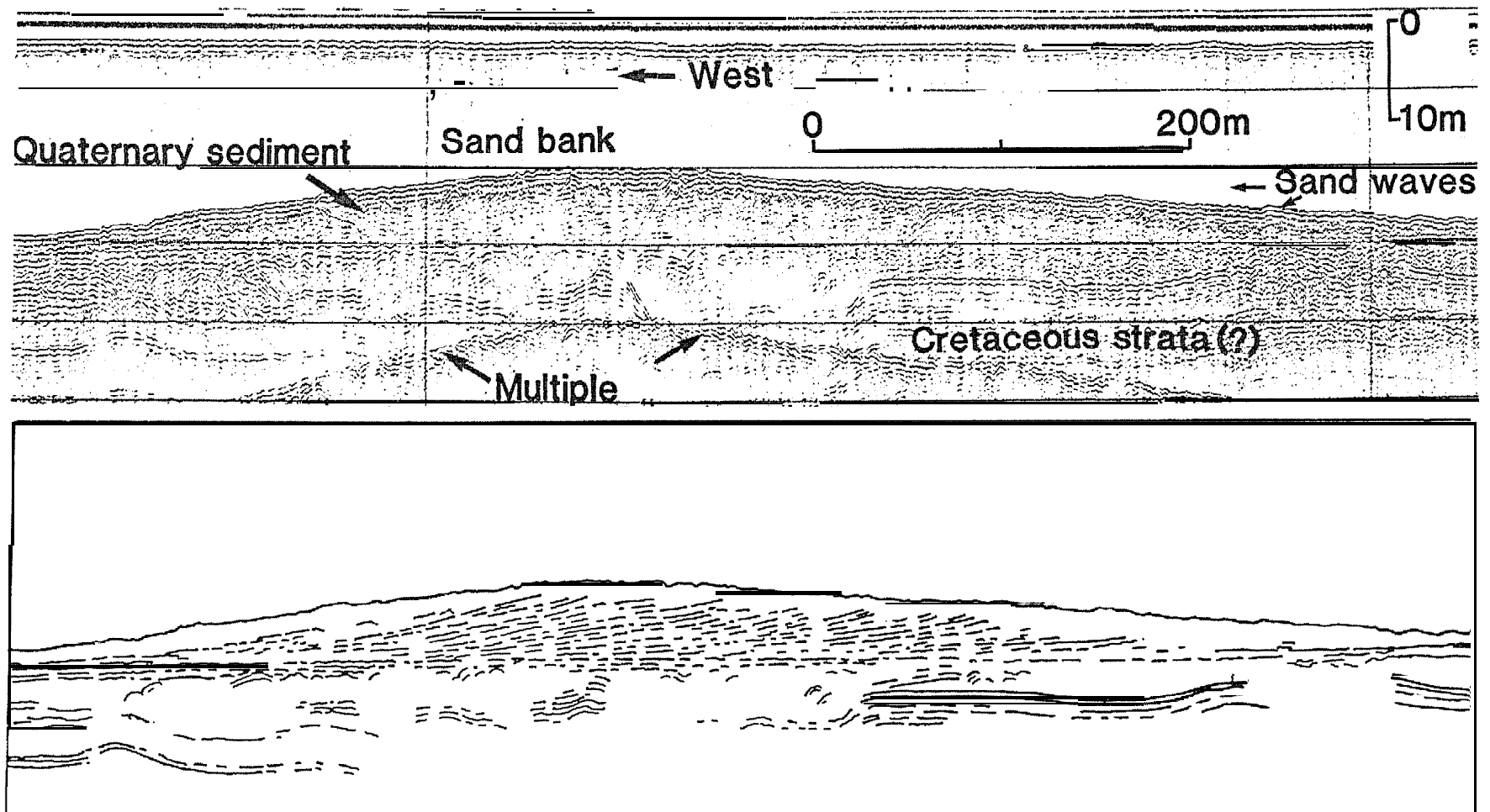


Figure 17. A) High-resolution seismic profile of sand bank off Icy Cape (see figure 9, area I-I', for profile location). Gentle northward inclined strata overlying a horizontal reflector (lag deposit) forms the internal structures of this sand bank. The northward inclined strata document a seaward migration direction of this sand bank. B) Tracing of internal elements recorded in the seismic profile.

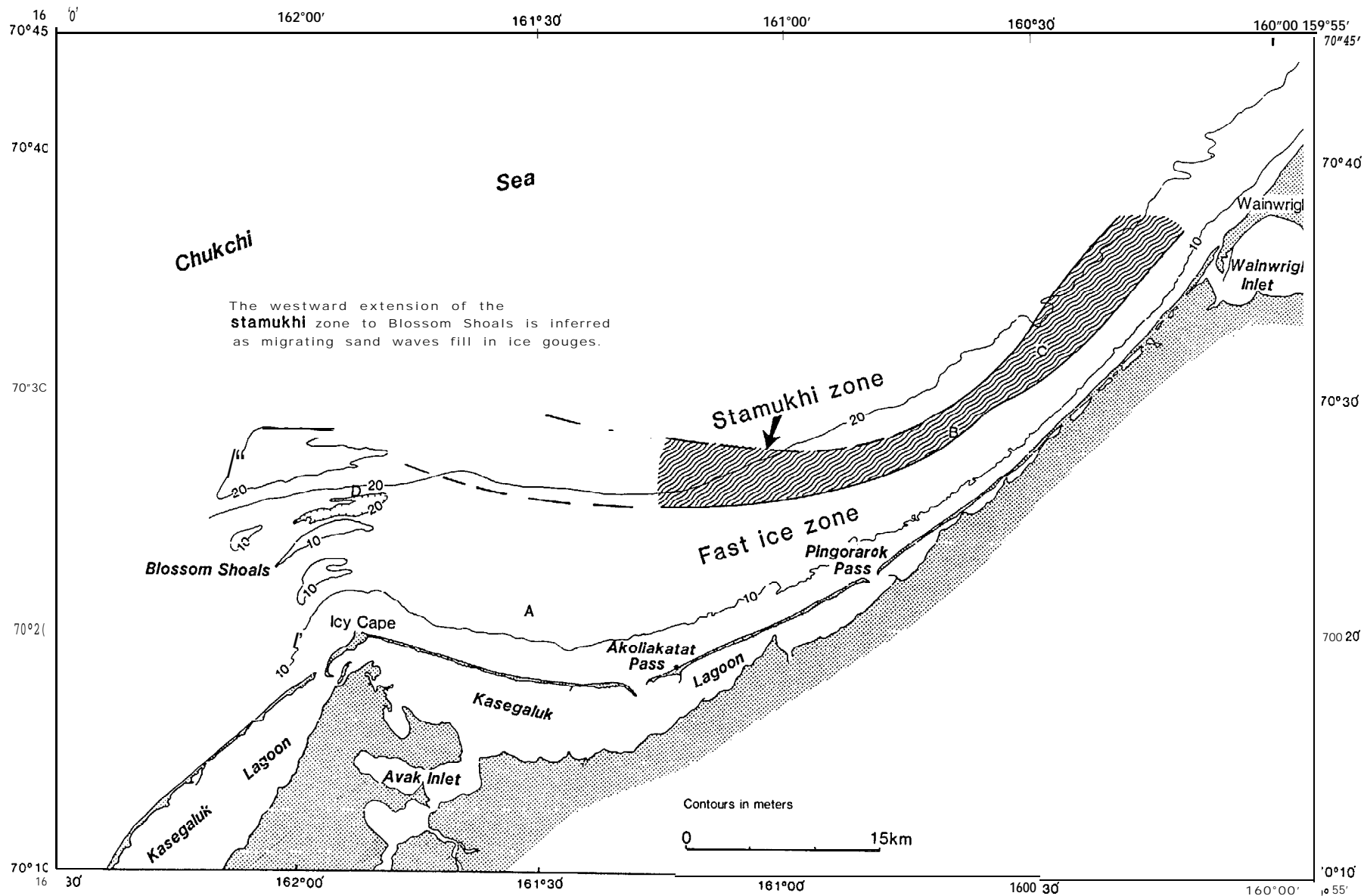


Figure 18. Ice zonation based on the abundance of ice gouges. The Stamukhi zone ranges from 16.5 m to at least 22 m depth and represents a region of intense ice gouging of the sea floor. The western projected trace of the Stamukhi zone toward Blossom Shoals is inferred as migrating bed forms, sand waves and ripples, apparently fill in the ice gouges near the shoals. The letters indicate sonograph locations.

gouge intensity (the stamukhi zone) is identified (figure 18). The gouge density increases to between 6 and 9 gouges per kilometer of trackline within the stamukhi zone (figure 20). Most gouges are oriented parallel to the shore line, locally gouge terminations can also be abundant. The maximum gouge depth was 50 cm, most gouges were between 20-30 cm deep. Ice gouges are also concentrated on the upper surface of local bathymetric highs or irregularities which may rise up to 1.5 m above the sea bed. The ice grounding may have formed these local areas of raised relief. Seaward of the stamukhi zone the ice gouge density **rapidly** decreases to less than 2 gouges per kilometer of track line. The outer gouges generally parallel the isobaths and are shallow less than 30 cm deep.

The deepest ice gouge observed during this study was 2.5 m deep located at 19 m depth on the seaward flank of the outer sand bank investigated off Icy Cape. Ice gouges on Blossom Shoals are generally restricted to the crests of the sand banks profiled (depths of 6 to **14 m** for sand bank crests), (figure 21). Sand wave migration probably filled **in** the ice gouges on the flanks of the banks.

The ice gouge intensity on the sea floor defines the **surficial** ice regime. Floating fast ice would dominate the nearshore zone to depths of approximately 16 m. The stamukhi zone defines the zone of grounding of the pack ice pressure ridges on the sea floor (figure 18). To the south toward Blossom Shoal the ice regime effects on the sea floor is poorly defined. The outer sand banks would tend to filter out the deeper draft ice flows, likewise, the complex reversing current pattern defined by the sand wave fields may result in complex pressure ridge ice grounding in the shallow regions adjacent to the cape. Movement of the sand waves, likewise, fills in the ice gouges in this region.

#### CONCLUSION

1. The offshore coastal region between Wainwright and Icy Cape contains a **thin** Quaternary sediment cover overlying Cretaceous strata.
2. Much of the **surficial** sediment will be coarse-grained sand and gravel lags, especially in regions of thin Quaternary sediment cover.
3. Locally in the nearshore region between Wainwright and **Pingororok** Pass kelp beds exist. The extent of these **biological-rich** areas is unknown.
4. The **paleochannel** of the Kuk River can be traced out onto the present shelf. The channel-fill sediments can locally obtain a thickness of 23m and may also contain gas.
5. A reversing but poorly defined current pattern exists off Icy Cape in Blossom Shoals. Northeast-directed currents

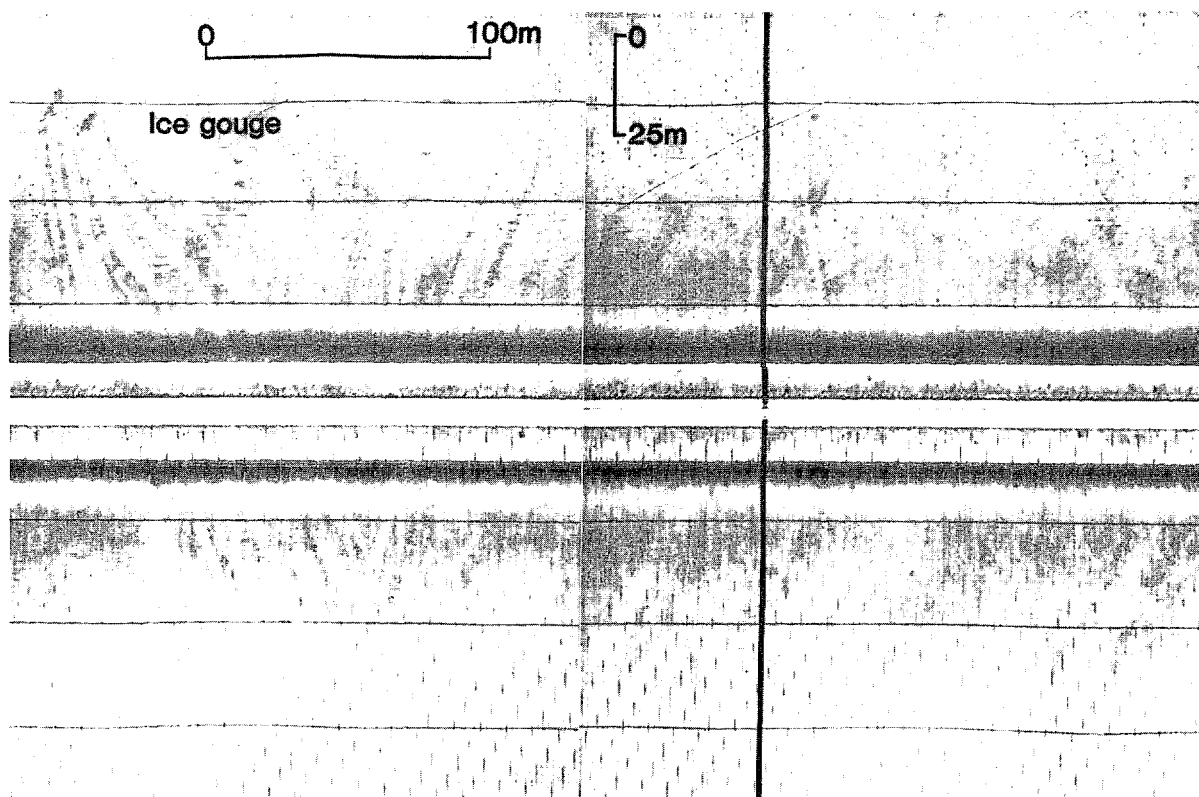
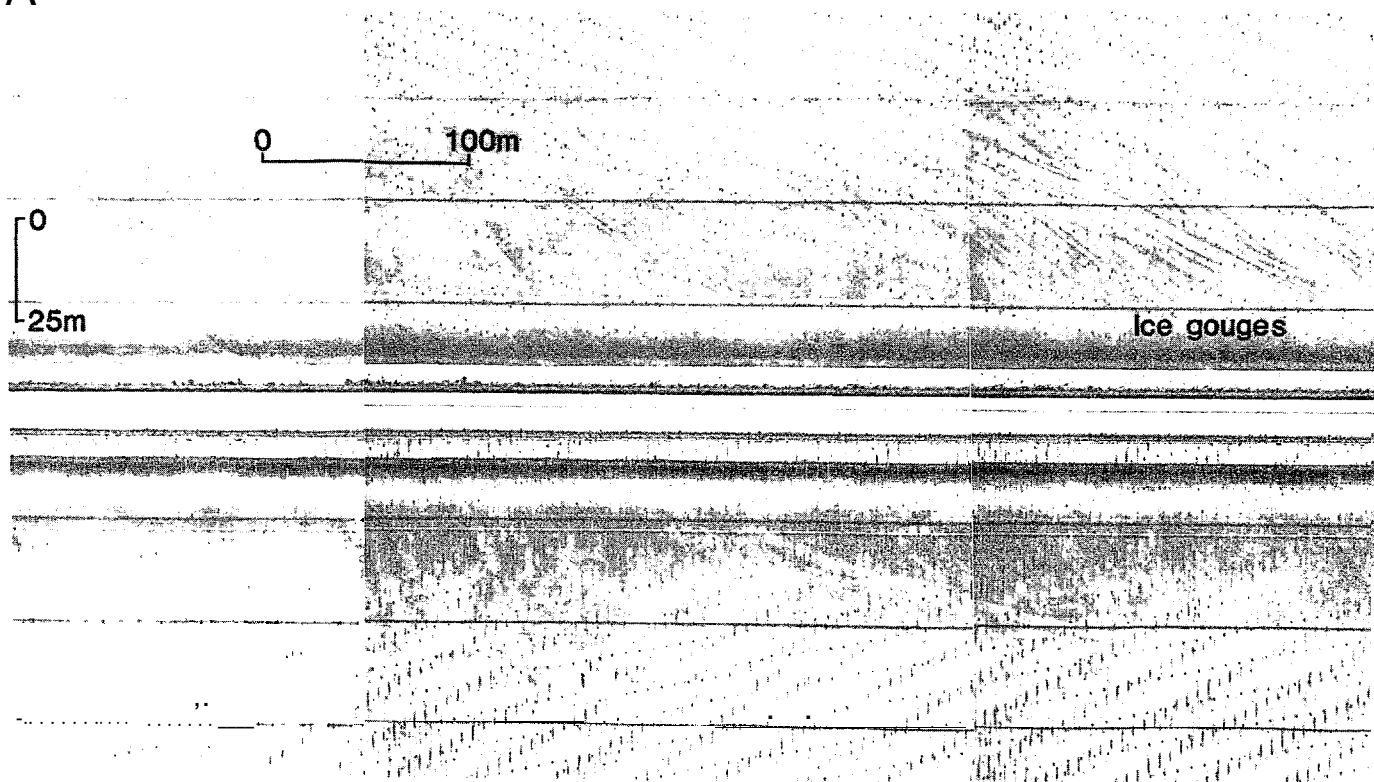


Figure 19. Sonograph of ice gouge termination (at left) at 13 m depth east of Icy Cape (see figure 18, letter A, for location of sonograph) . The ice gouges lie at an angle or parallel to the isobaths.

A



B

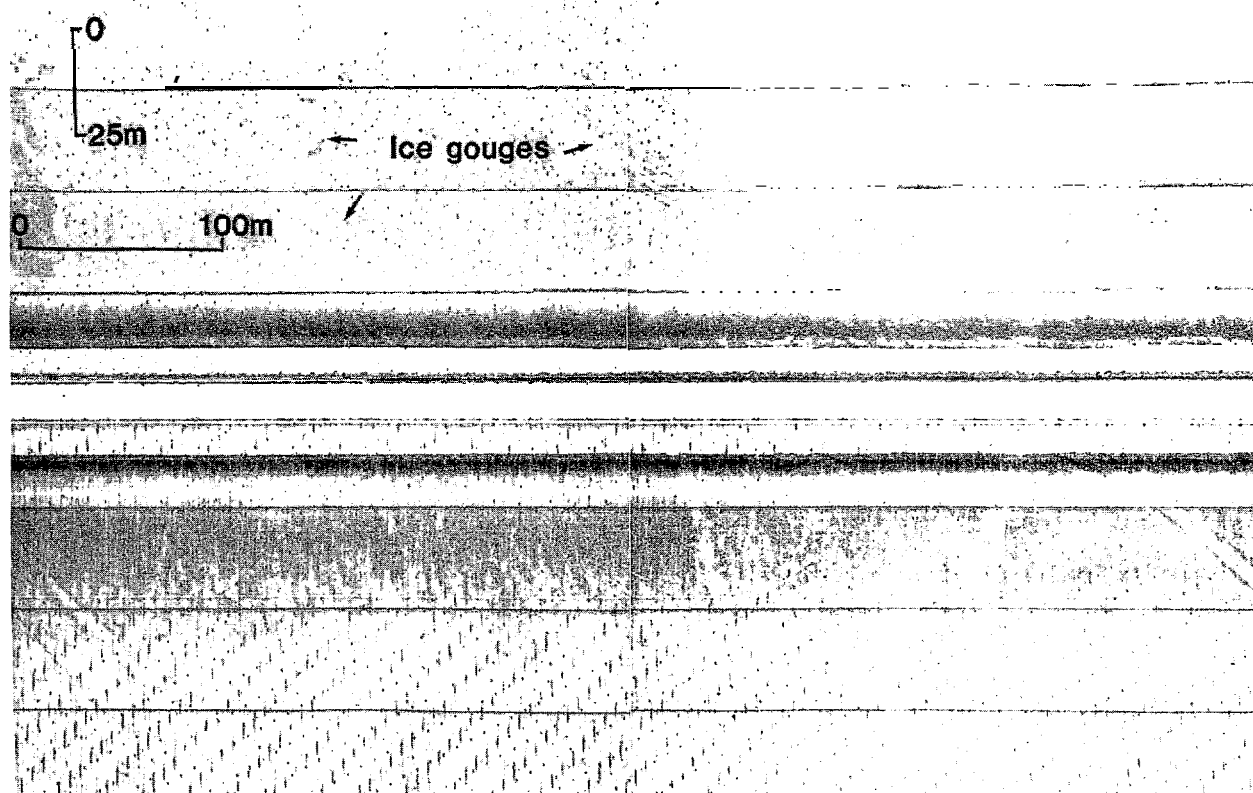


Figure 20. A) Sonograph of repeated ice gouges on the landward flank of the Stamukhi zone at 16.5 m depth (see figure 18, letter B, for location of monograph). B) Stamukhi zone, 18 m depth with ice gouge terminations (see figure 18, letter C, for location of monograph).

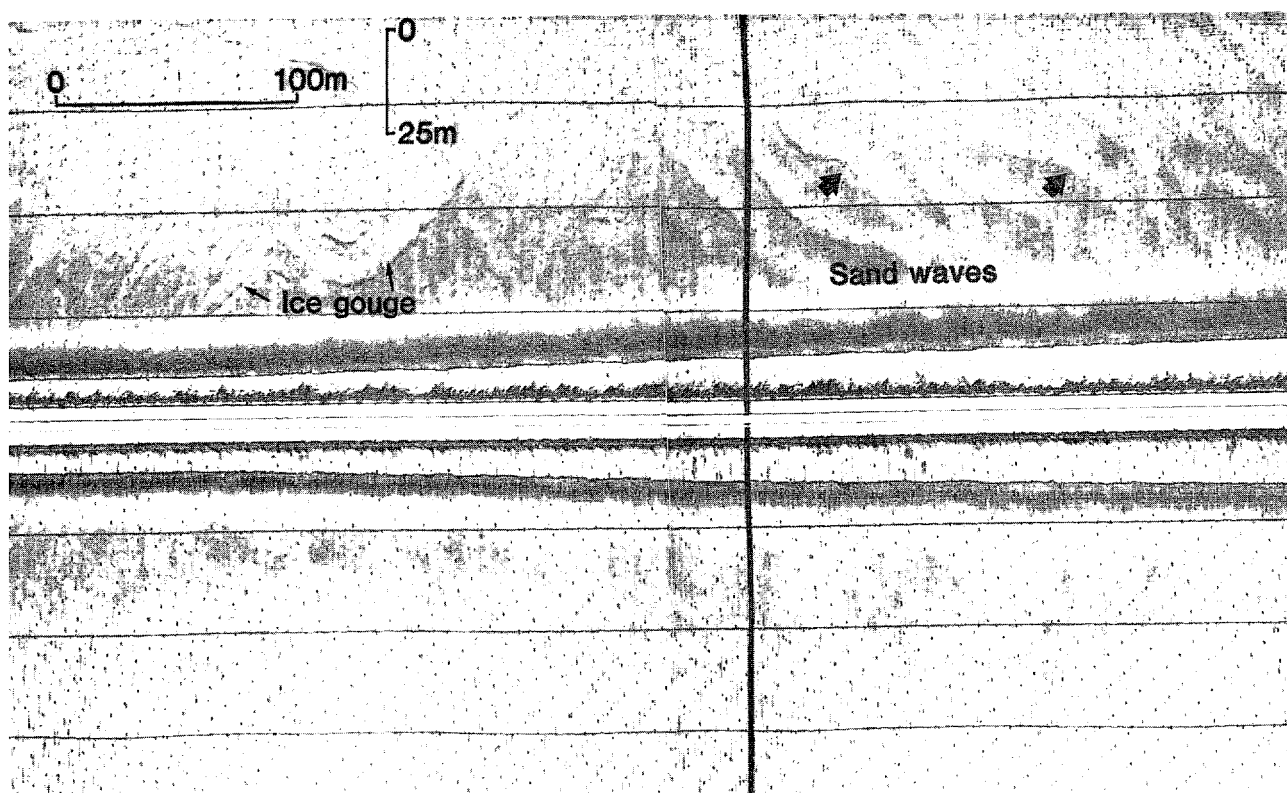


Figure 21. Sonograph of ice gouges on the crest of a sand bank at 14 m depth off Icy Cape (see figure 18, letter D, for location of sonograph). The arrows indicate the migration direction of the sand waves.

nearshore and western-directed currents offshore are indicated by orientation of sand wave fields.

6. Blossom Shoals represent a region of sediment deposition, forming parallel arcuate sand banks.

7. The sand banks as indicated from seismic profiles, are migrating in a seaward direction.

8. The maximum ice gouge intensity, the *stamukhi* zone, occurs between depths of 16 to 22.8 m parallel to the coast. Most of the gouges are oriented parallel to shore.

#### REFERENCES

- Grantz, A., Dinter, D. A., Hill, E. R., Hunter, R. E., May, S. D., McMullin, R. H., and Phillips, R. L., 1982, Geologic framework, hydrocarbon potential, and environmental conditions for exploration and developmental of proposed oil and gas lease sale 85 in the central and northern Chukchi Sea, U.S., Geological Survey Open file Rept. 82-1053
- Hufford, G. L., 1977, Northeast Chukchi Sea Coastal Currents, Geophysical Research Letters, v. 4, no. 10, p. 457-460.
- Hunter, R. E., Barnes, P. W., Kempema, E. W., and Reiss, T. E., 1982, Inner-shelf geology of the Chukchi Sea from Point Lay to Wainwright, in National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaska Continental Shelf: Annual Reports of Principal Investigators for the year ending March, 1982, p. B1-B18.
- Phillips, R. L., Reiss, T. E., Kempema, E. W., Reimnitz, E., and Richards, B., 1982, Marine geologic investigations northeast Chukchi Sea, Wainwright to Skull Cliff, in National Oceanic and Atmospheric Administration, Environmental Assessment of the Alaska Continental Shelf: Annual Reports of Principal Investigators for the year ending March, 1982, p. C1-C32.
- Short, A. D., 1975, Offshore bars along the Alaskan Arctic coast, Jour. Geol., v. 83, no. 2, p. 209-221.
- Short, A. D., 1979, Barrier island development along the Alaskan-Yukon coastal plains, Geol. Soc. American Bull., v. 86, p. 199-202